IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	)
	) Atty. Docket No.: ASAIN0058
Munehiro DATE et al.	)
	) Group Art Unit: 1774
Serial No. 09/434,498	)
	) Examiner: HESS, B.
Filed: November 5, 1999	)
	)
For: REVERSIBLE HEAT-SENSITIVE PAPER AND METHODS FOR WRITING INFORMATION	)))) Date: June 20, 2001

AMENDMENT (A)

Box: NON-FEE AMENDMENT
Assistant Commissioner for Patents
Washington, D. C. 20231

Sir:

In response to the Office Action dated March 20, 2001, please amend the above-identified application as follows:

IN THE SPECIFICATION:

The specification has been amended by replacing the following paragraphs. A marked-up copy of the relevant paragraphs is provided in accordance with 37 C.F.R. 1.121.

Page 1, line 12, replace the paragraph commencing with "A sheet of ....." with the following paragraph:

A sheet of conventional heat-sensitive recording paper is composed of a supporting base (for example, a paper sheet) provided with a heat-sensitive recording layer on the base, and when the sheet is heated by a heating head, heating pen, laser light, etc., information on image, barcode, etc. is written on the heat sensitive recording layer. However, such heat-sensitive recording paper has a disadvantage in that once information is written, the information cannot be

erased, so the paper cannot be used again.

Page 2, line 6, replace the paragraph commencing with "One of reversible ....." with the following paragraph:

One of the reversible heat-sensitive papers developed using such a reversible heat-sensitive recording material is, for example, leuco-based rewritable heat-sensitive paper using an electron donative dyestuff precursor. The electron donative dyestuff precursor is shown in Fig. 1; a lactone ring in the molecule opens in an acidic atmosphere and the precursor is colored, and by removing the acidic atmosphere, the lactone ring closes to resume a colorless state. The leuco-based rewritable heat-sensitive paper is combined with the electron donative dyestuff precursor and a reversible developer, where the reversible developer can reversibly create and erase a color through reactions with the electron donative dyestuff precursor. Typical reversible developers include, for example, a phenol-based compound with long chains in an alkyl group.

Page 2, line 21, replace the paragraph commencing with "Fig. 2 shows a ....." with:

Fig. 2 shows a coloring and uncoloring model. In Fig. 2, the electron donative dyestuff precursor and the reversible developer in a color-erased state (lower left) are heated, both are fused into a colored state (top), and when they are cooled quickly, the mix is solidified in a near-fusion state, thereby a solid colored state (lower right) is maintained. When the mix is gradually cooled, conversely, the electron donative dyestuff precursor and the reversible developer return to an erased state. Therefore, they can reverse to color or uncolor by quickly or gradually cooling the mix, respectively, after fusion. In addition, a solid mix in a colored state can be transited to the original uncolored state by maintaining the mix for a predetermined time in a

temperature range slightly lower than the melting point.

Page 3, line 8, replace the paragraph commencing with "Fig. 3 is a typical ....." with:

Fig. 3 is a typical sectional view of a reversible heat-sensitive paper 4 used conventionally for coloring and uncoloring with light. In Fig. 3, the numerals represent a base medium by 1, a photo-thermal conversion layer by 2, and a protection film by 3. On the surface of the thermal sensitive paper 1, is formed a reversible heat-sensitive recording layer 1a consisting of an electron donative dyestuff precursor and a reversible developer, formed by a coating method. The opto-thermal conversion layer 2 contains a substance that converts light with a predetermined wavelength into heat, and the substance is normally applied to the surface of the heat-sensitive paper 1, but the substance may also be dispersed in the reversible heat sensitive recording layer. In the opto-thermal conversion layer 2, an organic coloring matter that absorbs selectively light with predetermined wavelengths is normally used. The protection film 3 is a transparent film that protects the surface of the heat-sensitive paper 1 and the opto-thermal conversion layer 2, and is normally composed of a transparent plastic coating.

Page 4, line 26, replace the paragraph commencing with "The present invention ..." with:

The present invention has been achieved to solve the aforementioned problems. The object of the present invention is to provide a reversible heat-sensitive paper (1) the life of which is long and can be written on with a feeble light source, (2) into which a line smaller than a light flux used (for example, a spot diameter of laser light) can be written, thereby, the amount of information in, for instance, barcodes, etc., can be increased, and (3) into which two-dimensional information can be written within a short time, and methods for writing such information as

B5 Cont'd

described above.

Page 5, line 9, replace the paragraph commencing with "To achieve the first ....." with:

To achieve the first object (1), the present invention offers a reversible heat-sensitive paper comprising a reversible heat-sensitive recording layer that colors and uncolors its surface by controlling the changing speed of temperature and/or keeping temperature, and the reversible heat-sensitive recording layer being kept to a solid colored state. The reversible heat-sensitive recording layer comprises an electron donative dyestuff precursor and a reversible developer that colors and uncolors the electron donative precursor, and the reversible heat-sensitive recording layer being heated to a fused state, in advance, and then quickly cooled to a solid colored state. In addition, the present invention discloses methods for writing information on reversible heat-sensitive paper, where the reversible heat-sensitive recording layer is heated to a color-erasing temperature lower than the melting temperature, thereby, the layer is uncolored before use, and then information is written on the layer.

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Page 5, line 28, replace the paragraph commencing with "These reversible heat ...." with:

These reversible heat-sensitive paper and methods for writing information are characterized in that all of the surface of the paper is previously conditioned into a solid coloring state, and is partially uncolored to write information. In the remainder of the text, these methods are called "reversible writing methods" and the reversible heat-sensitive paper for reversible writing is called "reversible writing heat-sensitive paper."

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Page 6, line 8, replace the paragraph commencing with "In the reversible ....." with:

In the reversible writing methods, the entire surface of reversible heat-sensitive paper

B8

(reversible writing heat-sensitive paper) is in a coloring state, by which newly written parts are uncolored. Therefore, the methods are especially suitable for creating a negative image, however, the methods can also apply to producing a positive image. Through these means, the coloring matter of reversible writing heat-sensitive paper is in the state of a solid color and can highly absorb light. Once it absorbs light, its temperature easily increases. Therefore, a conventional opto-thermal conversion layer with a short life can be omitted, so the life of the entire reversible heat-sensitive paper can be prolonged. In addition, the paper can be written on with a weak light source (for instance, using small-output laser equipment), because the paper needs to be heated only within the range of color-erasing temperature, which is lower than the melting temperature.

Page 6, line 26, replace the paragraph commencing with "In addition, to ....." with:

In addition, to achieve the second object (2), the present invention provides methods of writing information on reversible heat-sensitive paper, in which the reversible heat-sensitive paper with a reversible heat-sensitive recording layer made from an electron donative dyestuff precursor and a reversible developer that can color and uncolor the aforementioned electron donative dyestuff precursor, formed on a base material, is irradiated with light to heat parts of the layer until the reversible heat-sensitive recording layer is molten, and then the layer is cooled quickly and the colored parts are irradiated with light partially in superposition, and the doubled parts are maintained at a predetermined uncoloring range of temperatures, that is lower than the melting temperature for a predetermined time, thus making the parts uncolored.

Page 9, line 7, replace the paragraph commencing with "Fig. 1 is a view ....." with:

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Fig. 1 is a view for describing coloring and uncoloring of a reversible heat-sensitive recording material.

Page 9, line 10, replace the paragraph commencing with "Fig. 2 shows ....." with:

B11

Fig. 2 shows a model of coloring and uncoloring of a reversible heat-sensitive recording material.

Page 12, line 20, replace the paragraph commencing with "More explicitly, the....." with:

More explicitly, the above-mentioned means can write information by setting the entire surface in a solid colored state (C in Fig. 4), beforehand, and by uncoloring parts of the surface during operation. Newly written parts are uncolored, therefore, the means are suitable directly for producing a negative image. However, by irradiating the means so as to leave necessary parts, a positive image can also be created, as in a conventional system. In the means, as described above, the coloring matter in a solid colored state absorbs light and generates heat, therefore, a conventional opto-thermal conversion layer with a short life can be omitted, so the life of the entire reversible heat-sensitive paper can be prolonged. Moreover, when writing, the means needs to be heated only to a color-erasing temperature range lower than the melting temperature, so the means can be written with a weak light source (for instance, using laser equipment with a small output).

B12

Page 14, line 13, replace the paragraph commencing with "According to the ....." with:

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According to the invented methods (writing erasing methods), light is irradiated to heat parts in which the reversible heat sensitive recording layer 2 is heated to a fused state, then quickly cooled to color the parts on which light is irradiated in superimposition, and portions

B13 cont'd

illuminated in superimposition are maintained at a color-erasing temperature range lower than the melting temperature for a predetermined time to uncolor the portions.

Page 15, line 6, replace the paragraph commencing with "According to the ....." with:

According to the aforementioned methods of the present invention (writing erasing methods), light (for instance, laser light) is irradiated to parts that have been colored by quick cooling, partially in superimposition, and doubled portions 6a are maintained in a color-erasing temperature range, that is lower than the melting temperature, for a predetermined time to uncolor such portions, so the doubled portions 6a can be uncolored, and single portions 6a can be colored in a normal state. Therefore, the width of a line in the single portions 6a can be made smaller than the light flux used (for example, spot diameter of laser light), thereby, the amount of information on a barcode can be increased dramatically.

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Page 16, line 14, replace the paragraph commencing with "To erase the entire ....." with:

To erase the entire surface, a heater, incandescent lamp or flash light source is used to heat the entire surface instantaneously, thereby, the entire surface is uncolored. Or, hot air etc. may also be blown.

B15

Page 16, line 18, replace the paragraph commencing with "Mechanism for ....." with:

Mechanisms for coloring and uncoloring the entire surface are substantially the same, and are controlled by heating temperature (a low temperature gives rise to uncoloring) or cooling rate (a long heating time may heat the layer more deeply down to the supporting base, resulting substantially in gradual cooling).

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Page 17, line 22, replace the paragraph commencing with "Using "reversible" ....." with: